



METHOD AND PRINCIPLES OF COMBINING FORAGE AND
PHYSICAL SURVEYS FOR RANGE LANDS

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The use of grazing lands must be based upon sound management plans if the soil, the basic resource, is to be preserved and at the same time produce maximum forage. Plans must be formulated from an integration of all important and significant biological and physical factors of the landscape.

The reconnaissance range survey developed by J. T. Jardine some 40 years ago has gone through a series of developmental stages leading up to the "Instructions for Range Surveys" compiled by the Interagency Range Survey Committee in 1937. These instructions are presently being revised and adapted to the particular needs of the Forest Service under the title of "Range Resource Inventories on National Forests." In the past the physical part of the landscape has been mentioned only briefly in range surveys and, with the exception of some adjustments for slope, no direct attempt was made to tie the physical factors in with range conditions. The purpose of this paper is to show how the physical conditions can be evaluated and used in Range Resource Inventories.

Many systems of land classification have been developed^{3/}. Langley^{4/}, working with the Grazing Service prepared instructions for compiling an inventory of the physical conditions along with the forage survey. These data, however, were not tied directly together. The use made of the soils information apparently supplemented the vegetative data only insofar as allowed by the experience and judgment of the party chief or person preparing the management plans.

Stoddard and Smith^{5/} report an instance where utilization cuts were based upon soils, slopes, and erosion. The resulting conservation adjustment factor in percent was applied to the forage-acre factor to obtain an "adjusted forage-acre factor." The method differs in some important respects from the one proposed here although both are directed toward the same end.

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^{3/} Jacks, G. V., Land classification for land-use planning. Imperial Bureau of Soil Science. Tech. Comm. 43: 1946.

^{4/} Langley, Glenn. Outline of principles, standards, and legend for mapping soil and erosion data. U.S. Dept. Int., Grazing Service, Idaho Region. Typewritten, April 1942.

^{5/} Stoddard, L. A., and Smith, A. D. Range management. McGraw-Hill Book Company, Inc. 1943 (citation from p. 231).

Practically all range surveys have failed to give adequate consideration to soil fertility and associated factors which are fundamental to all uses of the land.

The method herein reported on was developed by field trials over a period of two years and covering a wide variety of field conditions. The proposed method evaluates the physical landscape factors and provides a means of incorporating them into the grazing capacity estimates.

GUIDING CONSIDERATIONS

This work is based upon the tenet that the type of range management which will properly utilize present forage, and at the same time conserve the natural resources, must give appropriate consideration to both the vegetation and the physical factors. A range landscape^{6/}, however large or small, may be looked upon as having two parts: (1) the vegetal, and (2) the physical. The vegetal part consists of forage and other plants, the physical part consists of soils, terrain, and the destructive process--erosion. Climate exerts an over-all control and establishes over-all limits to which management must conform, but it is not considered in detail here because it is not susceptible (as yet) to man's control^{7/} and because it is essentially uniform over most management units in the range country. Economics and the biological complex are not considered because in most cases their state of being is almost wholly dependent on the vegetal and physical factors.

The ordinary range survey is primarily a forage inventory. In the survey such things as type, composition, density, utilization, trend, and condition are considered and recorded on maps. These data are used in formulating current management plans, but since vegetation is constantly changing the value of the original forage inventory decreases with time.

6/ A landscape is defined in the 1938 Agriculture Yearbook as follows: "The sum total of the characteristics that distinguish a certain area on the earth's surface from other areas. These characteristics are the result not only of natural forces but of human occupancy and use of the land. Included among them are such features as soil types, vegetation, rock formations, hills, valleys, streams, cultivated fields, roads, and buildings. All these features together give the area its distinguishing pattern. The term may be used in a broad sense to include the complex pattern of an extensive area, such as a rural landscape, the mountain landscape,--or it may be restricted more closely by some factors or combination of factors-----."

We use the term in both very broad and in narrow senses. The degree depends on the discussion. For example, we may speak of the landscape of the Grand Mesa which is a distinct unit. At the same time it contains many segments which differ distinctly from adjacent segments. Thus, we have the park type as a landscape distinct from the spruce type. Not only is the vegetation of these two landscapes different but the soils, erosion, and use are also distinctly different.

7/ Climate is susceptible to man's control in the sense that he has some control over the factors which influence moisture infiltration after the rains fall. Thus, he can influence "effective soil climate."

The forage inventory alone has several limitations:

1. It does not indicate the recovery potential of the site.
2. The present erosion condition and potential hazard is not evaluated.
3. Use adjustments based on forage alone may not adjust grazing use to a point where the site can start recovery.
4. Reseeding, revegetation, and other possibilities of erosion control and range improvement are not precisely evaluated.
5. The highest use potential of the site is not determined. It is assumed to be forage production but the area may have greater values for watershed or timber, or game, or recreation.

Basic data from the physical inventory supplements the forage inventory in several important ways:

1. They indicate potential capacity of the site to produce forage.
2. They give a more accurate basis for determining livestock adjustments needed to start a site-recovery trend.
3. The physical data are not affected by seasonal or short cycle climatic changes and therefore are a good record of site conditions.
4. The physical data provide a firm basis for judging the effects of past use and give a measure of the degree of present site condition.
5. A knowledge of the physical factors will distinctly aid in estimating the rate of site recovery or response to management.

The physical inventory survey following the method described herein performs other functions:

1. It locates and points up unusual sore spots and conditions.
2. Assures a greater degree of uniformity in evaluating physical site conditions over the region than is obtained when each party establishes its own standards. This will greatly assist in policy formation and action on a regional basis.
3. Supplies data basic for many other uses such as timber and water production; trail and road construction, range reseeding, tree planting, damage to site if grazed when wet, erosion hazards if denuded by grazing, fire or timber cutting, and general level of fertility.

THE METHOD

The development of the method and survey procedures described has been influenced by several important considerations:

1. Range lands have a low economic value per acre and survey costs must be held down.
2. Survey requirements and mapping units must be simple. The field men (often students) are trained in range and not soils.
3. The physical data gathered must not be more refined than required by the extensive type of management used on the range.
4. The method of computing adjustments must be simple and rapid.
5. The method must be usable by rangers and others to evaluate the physical conditions of range and watershed landscapes aside from regular inventory surveys.
6. It is recognized that some effort must be put forth by users to familiarize themselves with the method and to evaluate the physical conditions on the ground.

All basic field data for forage and the physical conditions are obtained by the same survey. Figure 1 shows graphically the steps involved. The forage inventory is conducted according to standard procedures using Forest Service Form 764a, except that utilization cuts for slope, erosion, and unstable soils are not considered a part of the forage inventory. The range surveyor records separately the physical data for soils, slopes, and erosion at the same time he makes the forage inventory. This results in two sets of data which must be brought together.

The gross grazing capacity of the unit or forage type as determined by the forage inventory is taken as the base on which to make additional adjustments. If the soils are good, the slopes gentle, and no erosion is present then no further adjustments in livestock numbers are made because of the physical factors. Grazing numbers are then based only on the amount of forage present or the gross grazing capacity becomes the net grazing capacity, except in special cases when additional adjustments are needed for lack of water, down timber, etc. These miscellaneous adjustments are made by the party chief or ranger and are not a part of this procedure. On the other hand, if the soils are damaged or deficient in some respect, the slopes steep, or serious erosion is present then adjustments are made in the gross grazing capacity according to the severity of the deficiencies. This is an acceptance of the two facts that proper range use depends first on the amount of available feed, and second, that if past use has been such as to result in serious damage to the ability of the site to produce a sustained yield of good forage, then use must be further adjusted to a point where the forage trend can be reversed and physical recovery obtained.

The physical factors are analyzed in three groups: (1) Soils, (2) slopes, and (3) erosion. The degree of disturbance, deterioration, or variation from an excellent or stable condition is given an index value between 0 and 10, depending on the degree of deterioration or departure from the excellent condition. For example, an area without sheet or gully erosion would have a value of zero (0), but a badly eroded and gullied area would have a value of ten (10). If the soils are erosion resistant, high in organic matter, fertile, and have good internal moisture conditions they likewise have an index value of zero (0), and as they depart from this top condition the assigned index value increases. A similar procedure is followed with slopes of increasing gradient. This assignment of values in terms of departure from the optimum greatly facilitates the final adjustment procedure. For example, if the sum of the physical factor values is low, no adjustment is made in gross grazing capacity, and as the index values increase a greater adjustment is indicated.

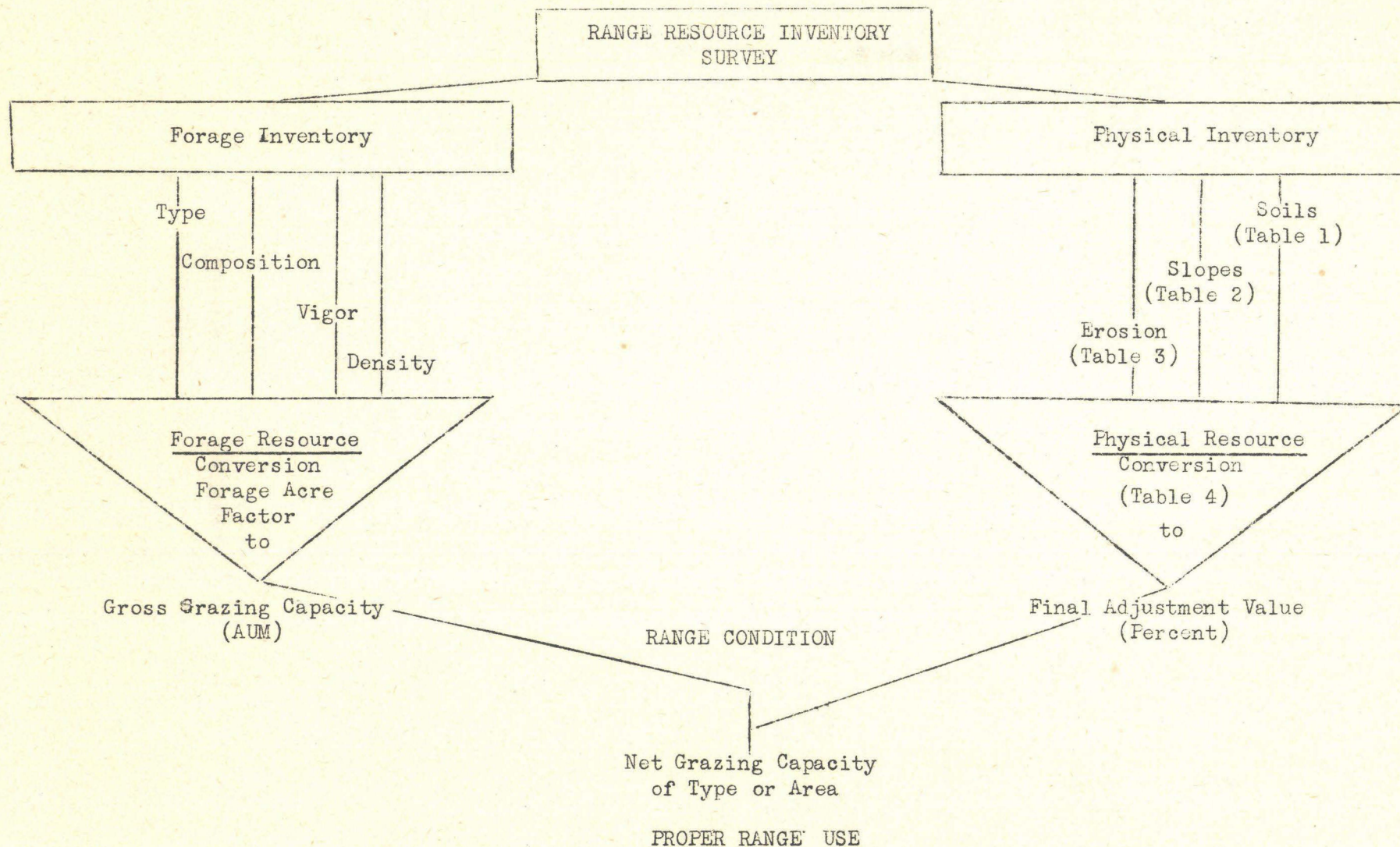
The values determined for each of the three factors--soils, slopes, and erosion--are added and the sum is converted to a percentage figure which is used to adjust the gross grazing capacity obtained from the forage inventory to the net grazing capacity. The adjustment can be made in the forage acre requirement or the number of animal units.

The method of using the index values for each of the three factors is given below. Four score cards are used, one each for soils, slopes, and erosion, and a fourth to convert the sum of the index values to a percentage basis. The cards are readily usable by the fieldman and can be carried in his notebook.

Soils

Soils differ widely in fertility, in ability to resist erosion and in their ability to absorb and retain moisture. Study of long protected field plots and undisturbed areas of native plants are one of the methods used to evaluate soil fertility, soil moisture relations, and erosiveness.

Fig. 1 Graphic presentation of steps involved in evaluating proper range use from the Range Resource Inventory Survey



The soils ratings (index values) need to be worked out by a soils technician who considers organic matter content, inherent erosiveness, fertility, moisture relationships, and other factors in assigning index values to different soils. Table 1, as an example, shows the soils and their index values for a particular area being worked by a range survey party. In assigning an index value of 10 to soils developed from Mancos shales in the shadscale desert, the soils technician considered their highly erosive nature, the high salt content and poor internal moisture relations. Soils from the same shale under more rainfall at higher elevations are highly productive of range forage. Soils developed from Windgate sandstone are infertile and highly erosive, and have an index value of 8. Soils developed from basalt are fertile and usually contain large amounts of organic matter. Because of good structural conditions they resist erosion if given adequate vegetative protection. Most soils developed from granites are moderately infertile and very erosive. These examples illustrate a few of the numerous factors that the soils technician must consider in establishing index values for soils on a comparative basis.

Ordinarily, a list of soils for a local area should not contain more than a dozen entries in Table 1. The soils technician and party chief determine the number of soil units needed for each area. They compile the data for this card. Any soil whose index value is 10 is excluded from all use irrespective of all other forage or physical values of the site. Where the soil has a value less than 10, the number is added to the values from Tables 2 and 3 and used as shown later.

To use Table 1 the surveyor must know the soils of the area. In most instances the differences are obvious and are easy to delineate in mountain and range areas.^{8/}

Slopes

Practical range management must consider slopes from two points of view. First, livestock have difficulty in getting over the range as the slopes become steeper. This is particularly true of cattle. As a result slopes greater than 60 percent are considered too steep to use under any condition and regardless of stability. Secondly, the erosion hazard increases as the slopes become steeper. Physical disturbance of the surface by livestock and the reduction in protective cover has an increasingly greater (hazardous) effect as the slopes become steeper, so in most cases the safe slope limit for grazing is less than 50 percent.

This interaction of slopes and ground cover is recognized in Table 2 where the index values for slope groups are tied to the range condition class.^{9/} Because two factors--slope and range condition--are considered, index values in the table range from 0 to 20. All values of 20 remove the type or landscape from all grazing use regardless of all other factors being considered. When the value is less than 20 for a particular area it is added to the values from Tables 1 and 3.

^{8/}Up to this time the soils listed in Table 1 have not been given names. They are identified only by reference to parent materials and the vegetative zone which also reflects the influence of climate. Soils developed from the same parent material may have very different characteristics, (and index values) when they occur in different climatic-vegetal zones. For this reason the mistake should not be made of placing all soils from the same parent rock in the same category. To avoid such mistakes it is planned to give all soils identifying names.

^{9/}Table 2 and its values are adapted, with some changes, from "Conditions and trends on ponderosa pine ranges in Colorado" by David F. Costello and H. E. Schwan, U.S. Forest Service, 1946. Mimeo.

Table 1.--Comparative Soil Indexes

Soil Parent Material	Cover	Index <u>a/</u>
Basalt drift	Pinon-Juniper	6
Basalt drift	Oak Brush	3
Basalt drift	Aspen	3
Basalt bedrock	Grass Parks	4
Basalt bedrock	Meadow	1
Mancos shale	Shadscale	10
Windgate sandstone	Oak-pine	8

Table 2.--Slope Indexes

Percent Slope	Range Condition Class Index <u>b/</u>					
	E	G	F	P	D	
0- 5	0	0	4	6	20	
5-20	0	0	4	6	20	
20-40	4	6	10	16	20	
40-60	6	10	20	20	20	
60-	20 <u>c/</u>	20	20	20	20	

Table 3.--Indexes of Sheet and Gully Erosion

Sheet Erosion		Gully Erosion	
Degree	Index <u>a/</u>	Degree	Index
None	0	<u>Occasional</u>	
Slight	2	Shallow	1
Moderate	5	Deep	3
Severe	10	<u>Frequent</u>	
		Shallow	5
		Deep	10

Table 4.--Final adjustment values for sums of indexes from Tables 1, 2, and 3

Index Sums Between	Percent Adjustment <u>d/</u>
0-11	0
12-13	12
14-15	25
16-18	37
19-20	50
21-23	75
23+	100

a/ A value of 10 removes the type from all use.

b/ E - excellent, G - good, F - fair, P - poor, D - depleted.

c/ A value of 20 removes type from all use.

d/ Add values from Tables 1, 2, and 3. The sums in left column correspond to the percent adjustment in right column.

Erosion

Unquestionably the character of the soils, rocks, and the degree of slopes are important contributing factors to erosion but improper land use is an added factor. The acceleration and extensiveness of erosional losses--sheet, gully, and wind--point to improper use as the major factor.

The range surveyor is concerned with both the kind and degree of erosion. His evaluation of the condition is based on definitions and instructions from the party chief. The problem is divided into sheet and gully erosion with values for the different degrees as shown in Table 3. When values of 10 or more are obtained by adding the value for sheet and gully erosion the site is excluded from all use regardless of the other forage and physical factors. The following discussion sets forth the procedures and the guiding definitions used by the surveyor in mapping sheet and gully erosion:

Sheet erosion:--Sheet erosion on areas above streams usually precedes the development of gullies in the drainage ways. The degree of surface soil deterioration is important knowledge to range management. Not all soils have the same thickness of surface horizons. Therefore, to classify soil losses into four categories it is necessary to define the categories in terms of percentage losses. These definitions are as follows:

No sheet erosion:--No soil losses or losses less than 10 percent of the original surface. Less than 10 percent of the area affected.

Slight sheet erosion: Surface soil losses range between 10 and 30 percent of the original surface soil. Thirty percent or less of the area affected. Usually rills present.

Moderate sheet erosion: Surface soil losses range between 30 and 60 percent of the original surface soil. More than 30 percent of the area affected. Condition usually accompanied by shallow and a few deep gullies.

Severe sheet erosion: More than 60 percent of the original surface soil lost. More than 30 percent of the area affected. Condition usually accompanied by deep gullies, exposed subsoils in some places and a scanty vegetative cover.

To evaluate soil losses, the amount originally present must be known. The soils technician determines this for each soil by studying relic areas and areas obviously not affected by accelerated erosion. In practical field mapping it is best for the surveyor to record on the map only the common depth of the soil remaining on the type or area. With these data it is easy to classify losses as to degree. The surveyor will find that the total ground cover--both live and dead vegetation--is a fairly reliable guide as to the percentage of the area affected by erosion.

The degree of erosion can only be satisfactorily determined by measuring the thickness of the surface soils in a number of places over the type. However, the range surveyor and the soils technician make use of a number of points in checking on the presence of erosion. The indicators of erosion are: (1) soil pedestals capped by grass, sedge, sticks, and flat stones; (2) exposed roots of

shrubs; (3) the lack of a lichen cover in a band around the lower part of rocks; (4) exposed subsoils; (5) buried surface soils in drainageways; (6) "growing rocks" or rocks with a light colored ring around their base; (7) gravel pavements; and (8) soil mounds or hummocks, especially if the area between the mounds has exposed subsoils.

Gully erosion.--Gullies indicate an unsatisfactory condition of the landscape above the drainageways. When more water rushes down than the vegetation can check, gullies develop.

Gullies pass through stages to complete a set of events known as a gully cycle. It is extremely important to range management to know the condition and relative abundance of gullies in a landscape. The following definitions are given:

Shallow gullies: Gullies whose channels have not cut through into the subsoil or into the parent material of the soil.

Deep gullies: Deep gullies are those whose channels have cut through into subsoils or soil parent materials.

Occasional gullies: A condition where fewer than 30 percent of the drainageways in a type or landscape are gullies.

Frequent gullies: A condition where more than 30 percent of the drainageways in a type or landscape are gullies.

Final adjustment

It is necessary to convert the index values representing an evaluation of the physical conditions to some final value for adjustment of the gross grazing capacity. This is done by adding the values as determined by field examination from Tables 1, 2, and 3, and converting the sum to a percentage figure. This conversion is an empirical procedure worked out in the field and has been repeatedly checked. Practical range management dictated the minimum adjustment unit of 12 percent.

These are the final adjustment values for the physical conditions of the range and are used to adjust gross grazing capacity values, to obtain net grazing capacity for the type. In a few cases this net grazing capacity may need be further adjusted by the rangers to take care of water conditions, inaccessibility, etc.

EXAMPLES OF APPLICATION

This method of combining range and physical surveys as a means of obtaining site evaluations and a net grazing capacity has been tested in the field for two seasons by the range survey parties on the Pike and Grand Mesa National Forests, where conditions are widely different. As a result of these trials many improvements have been made both in the method itself and in the manner of integrating the two kinds of data. The results of these experiences are discussed separately for the two forests since the applications differed considerably.

Pike National Forest

Kind of survey.--The Pike survey was a standard range survey designed primarily as a forage inventory. However, by including a physical inventory it may also supply basic data needed for multiple land use planning for the entire forest with special emphasis on watershed management.

Training.--At the start of the season the surveyors were trained to recognize differences in the physical factors as well as in vegetation. They were taught to recognize different soils and to evaluate differences in degrees of slopes and erosion. They were shown how to use the score card system to obtain net carrying capacity from gross carrying capacity. This early training required that the party chief and the soils technician be previously well acquainted with local conditions.

Field methods.--In this survey vegetation type boundaries were used as soil boundaries. In a high percentage of cases this is a satisfactory procedure and facilitates the survey. But there are important exceptions. For example, on depleted ranges the cover is depleted over good and poor soils alike and, therefore, vegetation type boundaries do not show important soil differences. In a reseeding program it is very desirable to know the location and extent of the better soils.

On this survey all records of the physical conditions were placed on the back of the Range Survey Write-up Sheet (Form 764a). No symbols were used on the field sheets to show soils, erosion, or slopes. To compile a map showing all or a part of the physical data it will be necessary to refer to the write-up sheets for conditions and to the vegetation type map for boundaries.

Only limited use was made of the shovel in determining soil losses. More reliance was placed on observation of surface conditions as an indication of sheet erosion. This is not a satisfactory method. Slope classes were identified by the Abney level.

Application of results.--The gross forage acre value for each type was adjusted to obtain the net forage acre figure directly in the field by the surveyor. The final or net value was recorded on the type write-up sheet. When the final map was compiled in the office from the field sheets each type was identified by a symbol:

1 POA,TRI	vegetative type
20-00 (.10)	density--net F.A.F.(gross F.A.F.)
160-00	surface acres - forage acres

In the above symbol the forage acre figure would have been 16 if an additional adjustment for bad physical conditions had not been made.

Time.--It is estimated that the collection of the physical data by the surveyors required about 25 percent more time than would have been needed for the vegetative survey alone. No additional office work was required. It is estimated that the gross forage acres were reduced some 35 to 45 percent by applying the adjustment due to unfavorable physical conditions.

Limitations.--The method used for the physical survey on the Pike has some serious limitations from range and over-all planning needs.

The physical data are not recorded on maps. It is not possible for administrators to specifically locate problem areas, areas with very steep slopes or areas having important soil differences. These data should form the basis of management plans for timber, watershed, and recreational developments. They should supplement the vegetative inventory in the location of fences, water developments, and reseeding sites. A map showing the physical data could be compiled from information on the write-up sheets, but it could be much more readily done if the data were recorded directly on field sheets or on overlay.

Kannah Creek watershed

The resource inventory survey of Kannah Creek watershed was undertaken to obtain data for a multiple land use program. Watershed values were considered most important.

Training.--The surveyors were given an initial period of training in observing and recording the vegetation and physical conditions. The training period was short because the crew was already familiar with survey techniques. Slope and erosion conditions were complex. There were many soils where there had been but a few on the Pike. The training period emphasized thoroughness as obtained by many soil examinations and careful evaluation of erosion conditions.

Field methods.--The physical data were recorded on overlay using symbols for each type. A minimum of data was recorded on the back of Form 764a. It was usually found that vegetation and soil type boundaries coincided well enough that separate soil boundaries were not needed. This was not always the case; separate boundaries were used where needed.

The symbol placed on the overlay in each type area recorded 5 classes of data.

Symbol example

10 - E₂ - 11

OD - C

Symbol components

Soil - Surface cover - Depth of
surface soil

Gullies - Slopes

Each soil was assigned a number. There were 17 different soils. The area was exceptionally complex in this respect. Normally one would not expect more than this number of soils on an entire National Forest. It is doubtful that any more soils would be found in the Grand Mesa National Forest.

Surface cover is highly important because of protection it affords. It is a basic consideration in all erosion problems. The absence of surface cover - both live and dead vegetation - was classed in four groups as follows: E₀ 0-20%, E₁ 20-45%, E₂ 45-70%, and E₃ 70-100% of exposed surface soil.

The average depth of surface soil over a type was determined by digging. This average depth was recorded as the last figure in the numerator of the symbol. This method provided for the gathering of factual data by the surveyor without the necessity of his determining the amount of soil lost by erosion. The amount of soil lost by erosion was computed later by the soils technician.

Large gullies were shown by individual symbols. The development of small gullies over the entire type was evaluated and recorded in the type symbol.

Slopes were determined by the Abney level and recorded in the denominator of the symbol. The slope groups were as follows: A=0-10, B=10-20, C=20-40, D=40-60, and E=60+.

Because of the complexity of the area and because nothing was known of the soils before the survey it was necessary for a soils technician to remain constantly on the job. By so doing a high degree of uniformity was obtained in the field mapping. Also a good knowledge was obtained of soils which cover extensive areas in western Colorado.

Application of results.--All data were worked up in the Regional Office. The field sheets contained all data needed except the range condition class which was taken from the type write-up sheet for each type. Two basic maps were prepared - one for the vegetation inventory and one for the physical inventory. The entire procedure to obtain net forage acres - including the use of the score card values - was an office job.

To meet the special requirements of the Kannah Creek Survey many maps and sets of data were prepared which would not be needed for the ordinary resource inventory survey.

Time.--It was estimated that the time required for the physical survey equalled that for the vegetation survey in both field and office. Since this was a guinea pig area many of the techniques and procedures developed should assist in materially reducing this ratio of time in future surveys. Since a thorough covering of the ground is necessary for the forage inventory the additional time needed for the simultaneous physical inventory should not be greater than 25 to 50 percent.

Adjustments due to physical conditions.--The gross forage acre figure for the Kannah Creek allotment was 3,588.6. Further adjustments because of unsatisfactory physical conditions reduced this figure 845 forage acres or to a net of 2,743.6 forage acres. This over-all reduction of 23 percent ranged from 97.2 percent in the pinon-juniper type to no adjustment at all for some other types.

Limitations.--This type of survey is not considered to have serious limitations insofar as the classification of basic field data is concerned. The survey produced a complete vegetation and physical inventory recorded on maps in such manner as to lend itself readily to any type of use interpretation or classification needed. The additional expense involved was justified by the special nature of the survey. This survey should not be used as a yardstick in estimating the cost of future surveys where no special problems are involved.

Recommendations

As a result of experiences on the Pike and Kannah Creek areas several general recommendations can be made:

1. Range Resource Inventory Surveys will return greatest value for the expenditures if data are recorded for both forage and physical conditions in such manner that final maps can be produced for each of the two inventories; that is, a vegetation map and a soils or physical condition map. From these two basic maps many types of data can be easily compiled which form the basis of good land management. The soils' data will serve range management and all other needs equally well.

2. The physical inventory should be placed on overlay sheets by the surveyor. Type conditions should be identified by a simple but composite symbol which shows the type and condition of soils, slopes, and erosion. Significant physical type or soil boundaries should be recorded even though in some cases they may not coincide with vegetation type boundaries.
3. A soils' technician should work full time with the survey parties to insure uniformity of the physical data, to keep the number of physical types to a minimum and to collect such technical soils' data as are needed. He should become as familiar with vegetation surveys as with soil surveys.

APPENDIX

This section of the report discusses changes proposed for Tables 2 and 4. It appears that these changes have considerable merit in refinement of the procedure. However, the proposals have not yet been checked in the field. This will be done during the 1948 field season.

The arrangement presented in Table 2 presumes that all kinds of soils on the same slopes will erode to the same degree, other conditions being equal. It is well known that critical slope values are different for different soils. For example, soils developed from some types of granite are so erosive that slopes above 40 percent are not considered usable, while slopes on soils developed from basalt may be used up to 60 percent. It is proposed to set up two sets of slope values--one for "stable" soils and one for "unstable" soils. These values are shown in Table 5.

The second change proposes to substitute the total amount of protective vegetation for the range condition classes as now used in Table 2. From an erosion point of view the important factor is the total (both live and dead matter) protection an area receives from vegetation of any type. Of course, it is desirable to have a cover of good forage but a dense cover of oak brush will protect the soil just as well. Therefore, five degrees of classes of total protective cover are used as shown in Table 5.

This arrangement will facilitate the use of the tables by people not trained in making range surveys or recognizing condition classes. It will assist rangers in checking up on the physical conditions of their ranges even though a range survey may have been made some time previously.

By removing range condition class from Table 2 and substituting the percent of protective ground cover as shown in Table 5, it is desirable to reduce the maximum range of the index numbers from 20 to 10. The original value of 20 was used because the table included both degree of slopes and range condition. The latter connotes much more than total surface protection and for that reason the values were increased to 20.

Reducing these index numbers makes an adjustment necessary between the sums and corresponding percentages in Table 4. These changes are shown in Table 6, which will be used in place of Table 4 if the arrangement of Table 5 is adopted after field trials.

Table 5.--Index Values for Slopes (proposed)
(Substitute for Table 2)

Percent Slope	Percent of Protective Ground Cover									
	100 - 90 :		90 - 75 :		75 - 50 :		50 - 20 :		20 - 0	
	S	U	S	U	S	U	S	U	S	U
0- 5	0	0	0	2	2	3	3	5	10	10
5-20	0	2	0	3	2	5	3	8	10	10
20-40	2	3	3	5	5	8	8	10	10	10
40-60	6	10	5	10	10	10	10	10	10	10
60+	10	3/10	10	10	10	10	10	10	10	10

1/ Relatively stable soils.

2/ Relatively unstable soils.

3/ A value of 10 removes the type from all use.

Table 6.--Final adjustment values for sums
of indexes from Tables 1, 2, and 3
(Substitute for Table 4)

Sums Between	Percent Adjustment Values
0- 6	0
7- 9	6
10-12	12
13-15	24
16-18	36
19-21	54
22-24	72
25-27	100